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(54) IC ELEMENT HAVING BUMPS AND ITS PRODUCTION METHOD

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CLAIMS

1. An IC element having bumps, characterized by having a configuration in which tip parts of the bumps are exposed, and other parts are covered by a protective film.

2. A method for the production of an IC element having bumps, characterized in that in a method for the production of an IC element having bumps,

(a) a process during which a protective film is formed over the entire surface of the IC having said bumps and

(b) a process during which tip parts of the aforementioned bumps are removed to expose said bumps are provided.

DETAILED EXPLANATION OF THE INVENTION

INDUSTRIAL FIELD OF THE APPLICATION

The present invention pertains to an IC (integrated circuit) element having bumps (extrusions) and its production method.

PRIOR ART

An IC (integrated circuit) element having bumps is referred to as a flip chip and lately has been surface-mounted as a thick film for the printing circuit of a facsimile.

Accordingly, the cost can be reduced, so that demand for [the IC element] has tended to increase.

An explanation will be given below based on figures.

Figures 3 and 4 are diagrams for explaining a method of mounting a conventional IC having bumps.

Figure 3 shows a mounting method of so-called a flip chip (flip chip), which is bonded to a substrate using the face-down method usually utilized for a thick film and a thin film circuits. Figure 3 (a) is a cross section of the IC element; Figure 3 (b) is a cross section showing the condition of the IC element mounted on the circuit board; Figure 3 (c) is a plane diagram showing the condition of the IC element mounted on the circuit board.

The mounting method is characterized in that bumps (2) made of solder, gold, silver, copper, or nickel are provided on an IC element (wafer) (1). Bonding to the circuit board (3) is achieved by the bumps (2) through reflow by taking advantage of the melting point of the solder.

When [a metal] other than solder is utilized, such as gold, silver, or nickel, bonding to the circuit board (3) is achieved by means of thermocompression bonding or ultrasonic energy or combination of thermocompression bonding and ultrasonic energy. The circuit board (3) can be made of various kinds, such as glass type ceramic type, or plastic type. Then, it is a common practice to apply a resin coating in order to improve the reliability after face down bonding is performed.

The reason the coating is applied is that because the surface (1a) of the IC element having bumps is made of $SiO_2$ (silicon oxide), PSG (phosphorus, glass), Al (aluminum), or $SiN_4$ (silicon nitride), moisture resistance becomes deteriorated. Thus, in order to prevent moisture from intruding, usually a silicon type resin (for example, JCR-6110) coating is applied first, and an epoxy type resin coating is applied after that. Although this coating may be of the silicon type resin coating as is or the epoxy type resin coating alone depending on required reliability, in general the epoxy is subject to great contraction stress during the curing, so that the surface of the IC chip may become damaged. Thus, caution needs to be exercised.

Furthermore, in Figure 3, (4) is a nickel/gold-plated wiring pattern formed on the circuit board (3), and (5) is a sealing resin.

Figure 4 are diagrams for explaining a method called tape carrier bonding (tape carrier bonding) or TAB (tape automatic bonding) to show another convention example. The method has the following characteristics.

The method is divided into inner lead bonding (refer to Figure 4 (a) and Figure 4 (b)) and outer lead bonding (refer to Figure 4 (c)).

First, as shown in Figure 4 (a) and Figure 4 (b), inner lead (14a) of plated lead (14) is bonded onto the bump (12) of the IC element (11). After so-called inner lead bonding is carried out, a resin (16) is applied for sealing, electrical measurement is performed, and outer lead (14b) of the assembled IC element (11) is bonded to the pad (18) of the wiring pattern (17) on the substrate (19) made of glass epoxy or ceramics, for example, as shown in Figure 4 (c). This is what is called outer lead bonding.

As for the leads for inner lead bonding, a copper plate pasted on a polyimide tape (13) is made into a lead shape through etching, solder plating or tin plating is applied, and the lead is bonded onto the bump (12) of the IC element (11) having bumps via said solder or tin layer (15) by means of thermocompression bonding or ultrasonic energy or combination of thermocompression bonding and ultrasonic energy. Then, because the surface structure of the IC chip does not change like in the case of the aforementioned flip chip, sealing is applied using a resin. This resin seal determines the reliability and the moisture resistance of the IC. However, when a liquid resin is used, the moisture resistance becomes subject to limitations since the bonding is applied only to the bump side.

## PROBLEMS TO BE SOLVED BY THE INVENTION

However, the IC element having the bump structure in aforementioned Figure 3 and Figure 4 is subject to the following problems.

(1) It has low resistance against intruding moisture. The reason is that the surface structure of the IC element has low resistance against moisture, so that the wiring electrodes often react with the intruding moisture and become corroded.

(2) Powders or pieces of silicon (Si) are adhered onto an IC element having bumps sometimes, and said [powders/pieces] damage the chip surface to make it defective when [the chip] is bonded onto the substrate.

(3) If an IC chip having bumps has a minor defect, after it is bonded face down onto the substrate, stress is applied to the surface of the IC element due to its contraction stress when resin sealing is applied. Thus, the minor defect is worsened, resulting in a failure.

The present invention is to eliminate the aforementioned problems and to present an IC element having bumps and its production method.

## MEANS TO SOLVE THE PROBLEMS

The present invention has a configuration in which in an IC element having bumps, tip parts of the bumps are exposed, and other parts are covered by a protective film in order to solve the aforementioned problems.

The method for the production of the IC element having bumps has (a) a process during which a protective film is formed over the entire surface of the IC having the bumps and (b) a process during which tip parts of the aforementioned bumps are removed to expose the bumps.

## FUNCTION

In the present invention, after bump processing is applied to an IC element which has gone through oxidization-dispersion-photolithography-vapor deposition process, surface of said IC element is soaked into an organic solvent containing epoxy resin coating material and dried subsequently to cure. A thin resin film is formed over the entire surface, including the surfaces over the bumps, of the wafer having bumps through this process. Subsequently, tip parts of the bumps are ground using an abrasive wheel in order to obtain specific metallic surfaces for junction. Subsequently, residues from the grinding are washed away, and scribing is applied to the IC element. The IC element having bumps which has been obtained in this manner is provided with a thick protective resin film on the front and the back surfaces. As a result of this

formation of the protective film, a protective capability against external impact during the scribing process and impact during the bonding to the substrate is attained, and a protective capability against the intrusion of moisture after it is mounted onto the substrate is also attained.

APPLICATION EXAMPLE

An application example of the present invention will explained in detail below in reference to figures.

Figure 1 is an oblique view of the appearance of the IC element having bumps showing the application example of the present invention. Figure 2 are cross sections of the production processes of the IC element shown in Figure 1.

As shown in Figure 1, the IC element pertaining to the present invention has a configuration in which tip parts of the bumps (26) of the IC element to be provided on the Si substrate (20) (silicon substrate) are removed to expose metallic surfaces (28) [sic; (29)], and other parts are covered by the protective film (27).

Next, the method for the production of the IC element of the present invention will be explained in reference to Figure 2.

As shown in Figure 2 (a), (20) is a Si substrate to which diffusion processing is applied to form a P-type diffused layer (21) and an N-type diffused layer (22), for example, and an $SiO_2$ film (23) is formed on it at the same time. Subsequently, an Al (aluminum) conductive circuit (24) is created; protection treatment is applied by means of a PSG film (25) or a nitride film; holes are created on the protective film, that is, the PSG film (25) or the nitride film, by means of photolithography only at the positions where bumps are to be created; a metallic layer (26) is formed; and bumps (27) are created on said metallic layer (26). In general, the creation of the bumps (27) is achieved by means of electroplating of bump materials. After said electroplating is completed, the metal is removed ultimately except where the bumps are present in order to obtain the bumps (27).

Next, as shown in Figure 2 (b), a protective film (28) made of an epoxy resin for example, is formed on the wafer which is finished with the bump processing. That is, first, once the bump processing is completed, the wafer is kept in such a way that it is free from dust. If adhesion of foreign matters or dust has occurred, [the wafer] is cleaned. Prior to the formation of the protective film on the wafer, undiluted solution, for example an epoxy resin (for example, commercially available CC-01-L3), of the treatment solution is diluted using an organic solvent such as acetone, and the wafer is soaked in the mixture. The mixing ratio then is determined by the thickness of the protective film required. Once [the wafer] is soaked therein, [the solution] is agitated well and coated to the root parts of the bumps without forming bubbles. After the

coating is completed, said epoxy film is cured fully. In terms of the curing conditions for achieving a uniform coating film without forming bubbles, 2-stage curing is preferable; wherein, the organic solvent is splashed away on the low-temperature side at 100°C for 30 minutes first, and [the film] is cured fully on the high-temperature side at 200°C for 60 minutes.

Furthermore, in addition to the aforementioned epoxy resin, for example, an epoxy type, a polyimide type, or a silicon type resin may be utilized.

Under the condition in Figure 2 (b), bonding is disabled because of the protective film (28) on top of the bumps when bonding on the substrate face down. Thus, in order to remove the protective film (28) uniformly from the tips, the entire wafer is chucked, [the wafer] is held on a table by means of vacuum (vacuum) with the side having the bumps facing the front, and a magnet is installed as a chuck table for the wafer on an object equivalent to the table of a drill press at the position where the drill is attached and is rotated in order to expose the metallic surfaces (29) at the top of the bumps as shown in Figure 2 (c). Not to mention, many methods are available for exposing the metallic surfaces (28) [sic; (29)] of said bumps, and [the wafer] may of course be sent to a wrapping machine to carry out the processing. Because the wafer treated in the aforementioned manner accumulates detritus, it is washed clean and dried before an IC element having bumps and the protective film is obtained ultimately.

Furthermore, the present invention is not limited to the aforementioned application example; various kinds of modifications are possible based on the tenor of the present invention, which is not removed from the claim of the present invention.

## EFFECT OF THE INVENTION

As described above in detail, because the IC element having bumps in the present invention has a protective film except at the tip parts of the bumps,

(1) When individual dices are created [from a wafer] and picked up and placed into a dice tray using an suction tweezers after scribing, surfaces of the dices do not get damaged because of the protective film. On the contrary, in the case of the conventional method, the scribing (51) carried out when making dices from the wafer creates powder, and the powder adheres to the air tweezers, so that the surfaces of the dices are damaged as the dices are under suction.

(2) When the scribed dices are bonded face down onto the actual substrate, if there is intervening foreign material, the surfaces of the dices are damaged. However, in the case of the present invention, the surfaces of the dices are not damaged because of the protective film even if there is intervening foreign material.

(3) As a result of the formation of the aforementioned protective film, protective capability against the external impact during the scribing process and the impact during bonding

to the substrate is attained, and protective capability against the intrusion of moisture after it is mounted onto the substrate is also attained.

Especially, when configuring 1 circuit using several dozen IC elements, if 1 of the IC elements is defective, the whole circuit becomes defective, resulting in a great loss. However, the reliability of a circuit configured by combining the aforementioned highly reliable IC elements can be improved.

## BRIEF EXPLANATION OF THE DRAWING

Figure 1 is an oblique view of the appearance of the IC element having bumps showing the application example of the present invention Figure 2 shows cross sections of the production processes of the IC element shown in Figure 1. Figure 3 and Figure 4 are diagrams for explaining the mounting method of the conventional IC element having bumps.

20 ... Si substrate; 21 ... P-type diffused layer; 22 ... N-type diffused layer; 23 ... $SiO_2$ film; 24 ... Al (aluminum) conductive circuit; 25 ... PSG film; 26 ... metallic layer; 27 ... bump; 28 ... protective film; and 29 ... metallic surface.

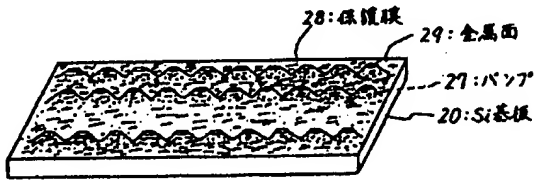



Figure 1: Oblique view of the appearance of the IC element having bumps of the present invention

Key: 20 Si substrate
27 Bump
28 Protective film
29 Metallic surface

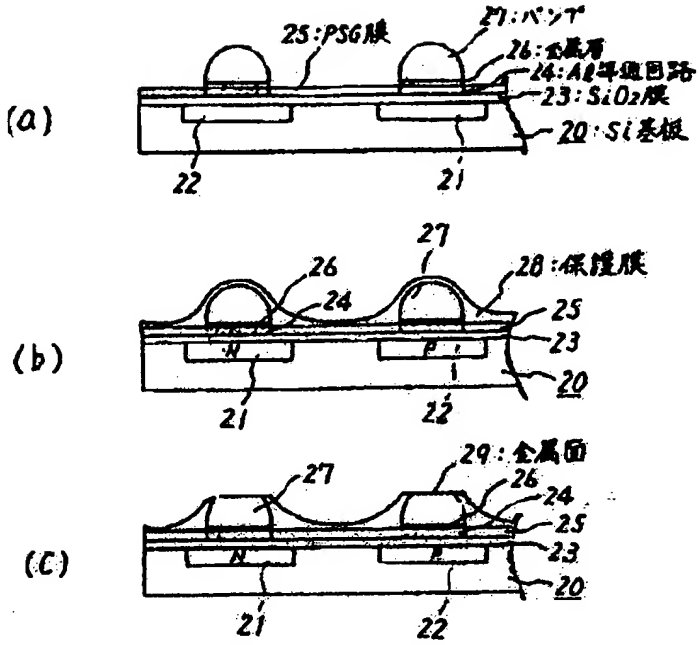



Figure 2: Cross sections of the production processes of the IC element having bumps of the present invention

Key:
| | | |
|---|---|---|
| | 20 | Si substrate |
| | 23 | $SiO_2$ film |
| | 24 | Al conductive circuit |
| | 25 | PSG film |
| | 26 | Metallic layer |
| | 27 | Bump |
| | 28 | Protective film |
| | 29 | Metallic surface |

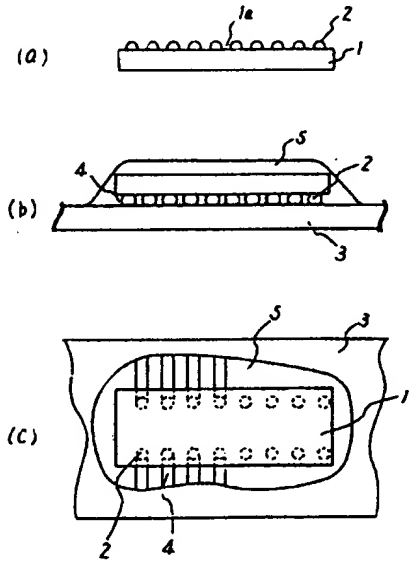



Figure 3: Diagrams for explaining the mounting method of the conventional IC element having bumps

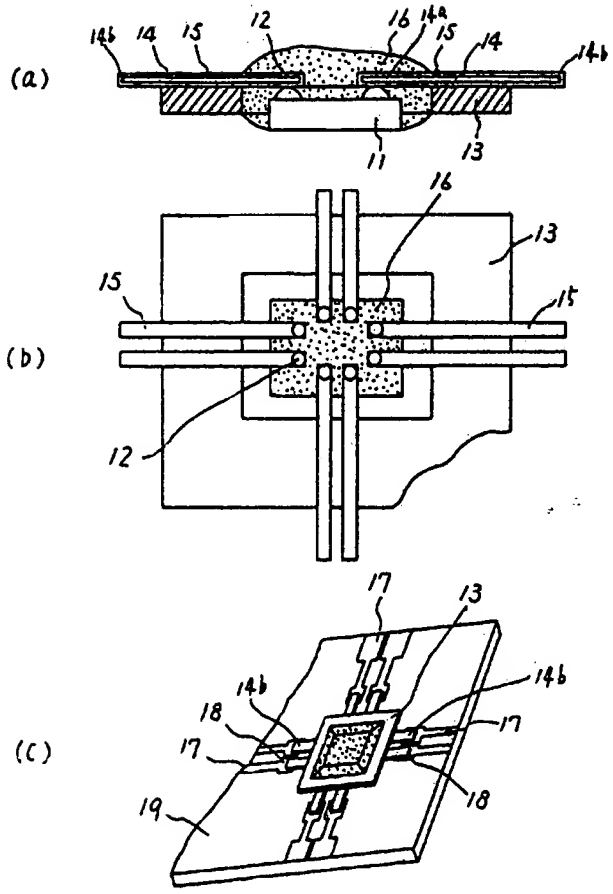
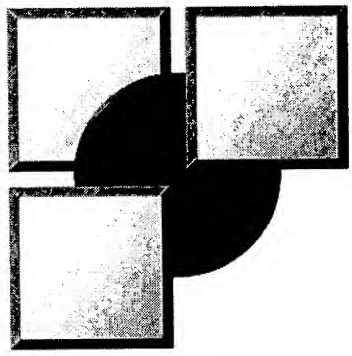



Figure 4: Diagrams for explaining the mounting method of another conventional IC element having bumps

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